nation-needle indicates the direction of the magnetic pole. At the present time in London the needle points 18° to the west of true or astronomical north; hence, if auroral arcs were seen here to-night, their highest points would be nearly certain to be west of north. Next, the dipping- or inclination-needle (a very cheap and admirable form of which is now sold by Mr. Casella) points to the magnetic zenith, which now in London lies 22° north of the true or astronomical zenith, in the magnetic meridian joining the north and south magnetic points of the horizon. Hence, if an auroral corona were seen here to-night, it would be nearly certain to lie in a point 22° north of the zenith.

Let us limit ourselves for the present to the arc. In our latitudes, as has been said, it is seen to the west of north, generally low down near the horizon; but in the far north on the same magnetic meridian as ourselves it is seen east of south, while also in the far north, but in a widely different longitude—that of Behring's Straits—it is seen north-north-east.

Evidently, then, this arc—this "common auroral arc," as it has been called by Nordenskjöld—is produced by a ring at some height between us and the north pole, but its centre does not lie at the north pole. Putting such observations as those referred to together, Nordenskjöld inferred the centre to be near the magnetic pole but not at it, in 81° N. lat. and 80° W. long., the thin ring of light having a radius of 18° and a height of 200 kilometres.

This, then, was Nordenskjöld's main conception—an immovable common arc (a permanent stria, to speak in vacuum-tube language), though he acknowledged additional ones sometimes, and shows by his observations that they are not always concentric.

He also attempted to explain the frequency and positions of arc auroræ in different places by dividing the polar lands into five concentric regions (see NATURE, vol. xxv. p. 368).

In Mr. Tromholt's volume we find what may prove to be an immense advance on this view. He holds that *the auroral zone moves northwards and southwards daily, yearly, and eleven-yearly.*

Again, to speak in vacuum-tube language, instead of one rigid stria, we may have many striæ, and these moving towards or away from the auroral pole as ordinary striæ move towards or away from the negative pole.

Next, as to the proofs of this movement, some more quotations from Mr. Tromholt may be given:—

"The daily period is apparent by a maximum of frequency and development which in most places in the globe occurs one to two, or three hours before midnight. This maximum seems, however, to occur *later* the nearer we approach the magnetic pole. This will be clear from the following series, in which the figure in parenthesis denotes the geographical latitude and the other the hour when the aurora attains its maximum in the place named:—

"Prague (50), 8¾; Oxford (52), 9¼; Kendall (54), 9¾; Makerston (56), 9⅓; Upsala (60), 9½; Christiania (60), 10; Bergen (60), 9⅘; Bossekop (70), 10½; Pustosersk (70), 11-12; Quebec (47), 10⅓; Fort Carlton (53), 12¼; Fort Simpson (62), 12; Point Barrow (71), 13½.

"For the Aurora Australis continuous series of observations are almost entirely wanting. It seems, however, from the fragmentary material which we possess, that the daily period for this does not differ from that of the Aurora Borealis.

"The individual types of the Aurora Borealis seem, like the phenomenon itself, to be confined to periods, and to attain their greatest frequency and highest development at certain periods. Thus, it appears from the observation of the previously mentioned French expedition to Bossekop, that the arcs appear on an average at 7h, 25m.; the streamers at 8h. 26m.; the auroral clouds at 11h. 18m.; the auroral waves between 13h. 12m. and 13h. 53m.; the intensest colours at 10h. 11m., and the greatest brilliancy between 10h. and 11h."

Next as to the yearly change.

Weyprecht was the first to advance the view that the auroral zone is furthest south at the equinoxes, and furthest north at the solstices. On this point Mr. Tromholt writes:—

"My researches have led me to endorse Weyprecht's theory. I feel satisfied that the *Aurora Borealis moves towards the autumnal equinox southwards, and then northwards, reaching its furthest northern limit about solstice. After this it again moves southwards, being in its most southern position at the vernal equinox, when the movement is again in a northerly direction.*

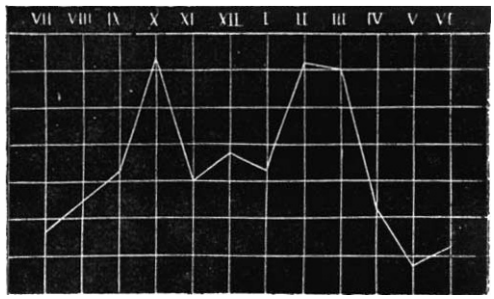

FIG. 3.—Curve of yearly auroral frequencies, Fritz. The Roman figures indicate the months.

"From this it follows that the two maxima occurring in the Temperate Zone at the equinoxes must approach each other more the further north the point of observation is situated. This is, in fact, the case. As some examples, I may mention that, whilst the two maxima occur [in March and September in St. Petersburg, Åbo, Stockholm, Christiania, Worcester (Mass.), and New Haven, they occur in February and October in Aalesund, Newberry, Quebec, and Newfoundland; in December to January in Hammerfest and in January at Fort Reliance. Very instructive in this respect are also the observations from the three Greenland stations: Upernivik, Jacobshavn, and Ivigtut. At Ivigtut, the southernmost of the stations, the yearly maximum must certainly be said to occur in January, but there is a second maximum towards the autumnal equinox. At Jacobshavn, eight degrees further north, there is but one distinctly marked maximum, in January, and at Upernivik, the northernmost of the stations, the maximum falls at the winter solstice more marked and dominant than anywhere else in the world."

(*To be continued.*)

THE ECLIPSE OF CHUNG K'ANG

IN China an eclipse of the sun is, and has in all ages been, considered as a bad omen. Indeed anything which disturbs the regularity of the movements or appearances of the heavenly bodies is so considered. "On the first day of the last month of autumn the sun and moon did not meet harmoniously in Fang." This passage occurs in the ancient classic, the "Shu Ching," in the "Yin Cheng," one of the books of the Hsia dynasty. Chinese commentators say that this passage refers to an eclipse of the sun in Fang, the fourth of the Chinese twenty-eight constellations. The last month of autumn, according to the Hsia Calendar, is the ninth month, the month after that month which contains the autumnal equinox.

The constellation Fang extends from about π to σ Scorpii, a distance measured along the ecliptic almost

equal to 5°. Approximately the limits of Fang were as follows:—

2250 B.C.	between	184	12	and	189	12
2150 ,,	,,	185	34	,,	190	34
2053 ,,	,,	186	56	,,	191	56

An eclipse near the constellation Fang will satisfy the conditions of the text, as at that early period, and for a great many centuries after, the Chinese were unable accurately to determine the position of the sun among the stars.

The date of the accession of the Emperor Chung K'ang, during whose reign this eclipse is said to have occurred, is unknown. Indeed all the dates in Chinese history before the Chou dynasty are unknown, the dates given in the common chronology being erroneous. The great importance of fixing the date of this eclipse is therefore apparent.

In all probability Chung K'ang reigned some time between the years 2050 B.C and 2158 B.C. I have therefore examined all years between these two dates on which an eclipse of the sun, in the constellation Fang, and on the first day of the ninth moon might be looked for.

Mr. Newcomb has published tables for the calculation of eclipses between the limiting dates 700 B.C. and 2200 A.D. I have extended these tables so as to embrace all eclipses of the sun between the dates 2200 B.C. and 2200 A.D. These tables thus extended I have used in the examination of this eclipse.

We might expect such an eclipse on or near the following dates:—

−2154 + ·64 years.	−2164 + ·82 years.
−2135 + ·25 ,, ...	−2145 + ·43 ,,
−2117 + ·86 ,, ...	−2126 + ·04 ,,
−2098 + ·47 ,, ...	−2108 + ·65 ,,
−2079 + ·08 ,, ...	−2089 + ·26 ,,
−2061 + ·69 ,, ...	−2071 + ·87 ,,
−2042 + ·30 ,, ...	−2052 + ·48 ,,

The dates on the left are the years and fractions of a year on which the ascending node is in longitude 180°, those on the right the years on which the descending node is in longitude 180°. The minus sign indicates B.C.

The situation of the capital of Chung K'ang is a disputed point. Some hold it was at An Yi Hsien, in Shan Hsi, latitude 35° 8′ N., and longitude about 111° 30′ E. of Greenwich; others say it was at T'ai K'ang Hsien, in Honan, latitude 34° 7′ N., and longitude about 115° E. of Greenwich.

Gaubil calculated the eclipse of the year 2154 B.C. to be the one in question. During this eclipse, however, it was night in China.

On October 22, 2136 B.C., the ninth of the cycle of days, the day Yen Shen, there was an eclipse of the sun, visible in the north of China. At An Yi Hsien it commenced about 10 a.m., and was over about half an hour after noon. The magnitude was about ·5. The longitude of the sun at the moment of true conjunction was 191°·38, so that the eclipse took place very near Fang. The day was the first of the ninth moon.

In the following year, 2135 B.C., on October 11, the third of the cycle of days, the day Ping Yin, there was an eclipse of the sun, also visible in the northern hemisphere. At An Yi Hsien the eclipse began about 4.30 p.m., and lasted till about 7 p.m. The magnitude was ·58. At the time of conjunction the longitude of the sun was 180°·28, so that the eclipse took place near Fang. Strictly speaking, October 11 was the first day of the eighth moon, but we need not expect the Chinese at that early date to have been able to determine the time of the equinox to a few hours.

We meet with no other eclipse visible in the north of China, and fulfilling the required conditions, till the year 2071 B.C. On October 23, the fifty-first of the cycle of days, the day Chia Yin of this year, there was an eclipse of the sun. At T'ai K'ang Hsien it began a few minutes after seven in the morning, and was over about 9.30 a.m. The magnitude was ·34. At conjunction the longitude of the sun was 193°·2. This eclipse also satisfies the required conditions near Fang, and occurring on the first day of the ninth moon.

The eclipse of the year 2127 B.C. deserves consideration, as it is generally considered to have been the eclipse in question. On October 13 of this year, the forty-seventh of the cycle of days, the day Keng Hsii (all dates are given according to the Julian calendar), there was an eclipse of the sun. The "Bamboo Books" say that this eclipse took place in the fifth year of Chung K'ang, the thirtieth of the cycle of years in the An Sunn and on the first day of the ninth month, the day Keng Hsii (forty-seventh of cycle). This account of the eclipse must have been the result of an after-calculation, and is a proof of the wonderful accuracy to which the Chinese astronomers attained in calculating back past eclipses. In this eclipse they are right in every particular. However, this eclipse was not visible in China so far south as either An Yior T'ai K'ang. The following table, which approximately gives the southern line of simple contact of the eclipse, shows this clearly:—

Latitude	Longitude
66° 14′ N.	96° 10′ E.
60 23 N.	139 27 E.
55 33 N.	152 28 E.
52 7 N.	158 35 E.

From the above investigation we see that the eclipse referred to in the "Shu Ching" in all probability must be that of one of the years 2136 B.C., 2135 B.C., or 2071 B.C.; which of these dates is to be taken must be determined by other considerations. The eclipse of the year 2136 B.C. may be the one in question. It occurred in the middle, the busiest part, of the day. A total eclipse would agree better with the accounts as given in the "Shu Ching." The hurry and bustle occasioned by the total want of preparation to perform the customary rites, and the penalty of death inflicted on the two astronomers, Hsi and Ho, seem to point to some adequate cause. However, I believe a great part of the account as given in the "Shu Ching" is legendary. It is taken for granted that Hsi and Ho were able to predict eclipses, and it is stated they were put to death because, giving themselves up to pleasure, they neglected their proper duties. But the Chinese at that early period, and for many centuries after, were not able to predict eclipses. They were not even able to observe the place of the sun with any degree of accuracy, which is proved by their Calendar so often falling into confusion. That the account of the eclipse itself is true, there is no reason to doubt. It is referred to in the "Tso Chuan," a book written about the time of Confucius. However, that the astronomers Hsi and Ho were put to death because they failed to predict the eclipse, appears very doubtful. It is much likelier they were put to death for rebellion, or some other political reason. Summing up the above investigation, we see that between the years 2164 B.C. and 2042 B.C. no eclipses of the sun in Fang, and on the first day of the ninth moon, were seen in the north of China, except in the years 2136 B.C., 2135 B.C., and 2071 B.C.

P.S.—In NATURE, vol. xxxi., p. 91, the eclipse of Thucydides is mentioned as having occurred on August 3, 431 B.C., and that, calculating this eclipse with Hansen's tables, the greatest phase falls at 5h. 9m. p.m., and the magnitude is ·75. Using Newcomb's tables of eclipses, I find the greatest phase falls at 6h. p.m., and that the magnitude was ·91. S. N. K.